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Decommissioning of the Risø Hot Cell Facility Contract FI2D-0011-DK

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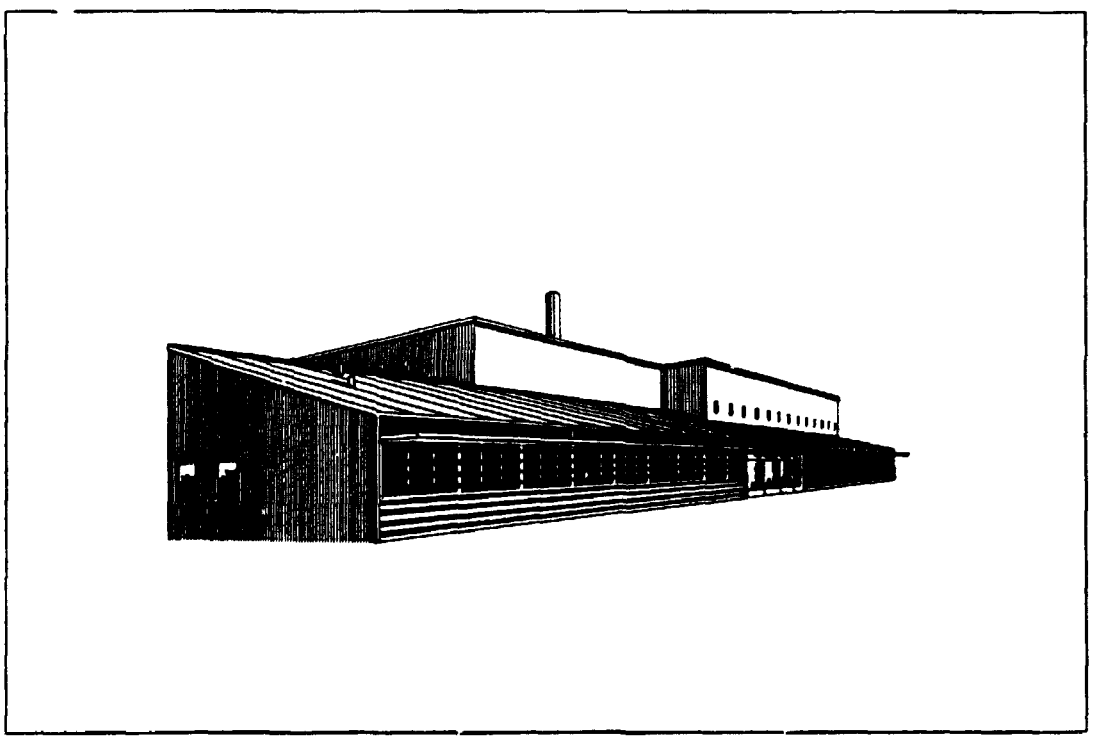

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1. REMOVAL OF FISSILE MATERIAL

All registered and Safeguarded fissile material has been removed. The item is completed.

2. REMOVAL OF LARGE CONTAMINATED EQUIPMENT

The task of cutting and packing of scrap material and experimental equipment from the concrete cell line has been finished. The item is completed, apart from some minor cleaning equipment and few waste containers that must remain during the final cleaning of the last cells.

3. REMOVAL OF LARGE CONTAMINATED FACILITIES

Concrete cells 5 and 6 have now been finally cleaned. The master slave manipulators for these cells have been removed.

At the top of each cell a ventilator is situated, producing the required flow and sub-pressure in the cell. The air from each cell is filtered through an in-cell filter before entering the ventilator, which means that the ventilator is only slightly contaminated. The ventilators on top of cells 5 and 6 have now been removed. After dismantling they were wrapped in plastic foil and will finally be placed in the corresponding cell. Their contribution to the radiation level in the cell will be negligible, so it is a convenient alternative to transferring them to the Waste Treatment facility for similar temporary storage there.

4. DECONTAMINATION OF CONCRETE CELLS

4.1 Shutters and shutter housings

As reported in RISØ-HOT-DECOM-P4 the major part of the contamination on the shutters and on the shutter housings were on the horizontal planes of the shutters, and the main contaminant was ^{137}Cs. Those results were based on smear tests.
The horizontal surface of each shutter has now been cleaned by thorough wiping with wet cloths; also all vertical surfaces within reach on the shutters and on the shutter housings were wiped. Access to the shutter housings was established through doors in the housing. Work through these open doors could be performed while retaining sub-pressure in the housing, but protective breathing filters and continuous monitoring were required. Before and after this wiping the activity level was measured in each shutter housing at a predetermined location.

Based on the measured activity and assuming that all activity comes from homogeneously distributed ^{137}Cs, the corresponding contamination level was calculated. The results are given in Table 1. It is seen that 37 - 70% of the contamination is removed by the wiping. The calculated contamination density in the housings after wiping ranges from 5 to 31 MBq/m^2 (on 14 m^2/housing).

No more cleaning of this part of the cell volume will be done because the contamination density is much lower than that obtained in the main volume of the cells, see item 4.2.2.

4.2 Concrete cells 5 and 6

4.2.1 Procedure

After some further "hot spot" removal these cells were prepared for the final in-cell cleaning.

In each cell

- the filter was replaced by a new one;
- the master-slave manipulators were removed;
- the cover plate to the conveyor running under the table was replaced by a new one, as the old one was heavily contaminated.
- all electricity supply was suspended;
- a movable lighting rack was taken to the cell;

Before the final cleaning the radiation and contamination levels were measured. 24 TL-dosemeters were placed in a convenient matrix in different heights above the table and the floor and exposed for 1 hour. Five α and five β/γ smear tests were taken on the table, on the floor and on the wall; the α- and β/γ -tests covered 1000 cm^2 and 1 m^2, respectively. Further, air samples of 1 m^3 in each cell were taken by air flow through a glass filter; they were taken at a time with heavy turbulence in the cells.

Each cell was then cleaned by high pressure water jetting. The equipment has the following characteristics:

- pressure supplied by the motor is 165 bar;
- pressure is increased by some turbo effect to 210 bar;
- water flow is 3.5 - 17 l/min;

The pump was placed outside the cell and supplied with water through a plug in the cell wall. The water was removed from the cell through a sump in the cell to the standard contaminated water reservoir at the facility. Monitoring of the outlet water before and after the operations confirmed removal of activity during the operation.
At first water with some detergent was applied to all surfaces in the cell. Next, all surfaces were rinsed by water without detergent, the water being applied first to the ceiling, then going downwards. Special care was taken to hit all joints and other narrow hollows. Finally all surplus water was pushed by a rubber scraper to the in-cell sump.
During the water jetting some new waste particles were found and more clean surfaces were generally observed; only few spots of painting were torn off. The water jetting lasted one hour per cell.

After the in-cell cleaning the radiation and contamination levels were remeasured similarly to the procedure applied before cleaning; the smear tests were taken at the same positions as before cleaning.

The above mentioned operations (measurements before/after and the water jetting) required approximately 10 man-hours.

4.2.2 Results

The measured contamination and activity levels are given in Tables 2 - 5, where a 100% efficiency of the smear tests is assumed.

The qualitative analyses of the α-smear tests show contamination with ^{235}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am, ^{244}Cm and ^{246}Cm.
The β/γ-smear tests show that ^{137}Cs is the dominating nuclide, and that the activity is inhomogeneously distributed, being lowest on the wall.
For cell 5 the efficiency of the smear test was high as seen in Table 2 from corresponding values before and after cleaning; further, the results show that no activity has been moved to these positions during the water cleaning. An extreme concentration on the floor, right, is noticed.
For cell 6 Table 3 shows that the contamination can have increased after the first smear test and the water jetting, indicating either a lower efficiency of the smear tests or more likely a relocation of the activity, as it happened on the floor.

Based on the smear tests and cell dimensions (10 m^2 floor/table and 60 m^2 wall) the total contamination before water jetting can be calculated to 40 and 0.2 GBq for cells 5 and 6, respectively. The similar calculation after cleaning is irrelevant as those smear tests were taken at positions identical to the previous positions and therefore not being representative for the remaining areas.

Based on the readings of TL-dosemeters number 2 as listed in Tables 4 and 5 the total contamination of each cell was calculated, assuming that ^{137}Cs is the only and homogeneously distributed contaminant. The results are given in Tables 6 and 7. For cell 5 the total activity is 149 GBq before cleaning and 102 GBq after cleaning; the similar numbers for cell 6 are 43 and 24 GBq, respectively. 32 and 44% of the activity in cell 5 and 6, respectively, have been removed by the cleaning. The final average contamination density after cleaning (on 70 m^2/cell) is 1.5 and 0.3 GBq/m^2 for cell 5 and 6, respectively. This density is much higher than that in the shutter housings, see item 4.1.

The results on the contamination in the shutter housings and in cells 5 and 6 are summarized in Table 8. The results based on the calculations from the TL-dosemeter readings are the reliable ones; the calculations on the smear tests are done only to check the results. For cell 5 the calculated contamination density as obtained from smear tests is of the same order of magnitude as that obtained from calculations on the TL-dosemeter readings. For cell 6 this is not the case, showing that the relatively few smear tests do not represent a true presentation of the contamination.

The analysis of the cell air samples taken before cleaning by water gave:

	α-contam. [kBq/m^3]	β/γ-contam. [kBq/m^3]
Cell 5	0.9	0.3
Cell 6	114.	44.

The activity in the contaminated water reservoir rose from 20 to 2000 mSv/h after the water cleaning operation.

The frogman work including measurements and water jetting gave a total collective dose of 11.8 man-mSv to 4 persons; the maximum individual dose was 4.7 mSv.

4.3 Concrete cells 1, 2 and 3

The work on remote cleaning by vacuuming and "hot spot" removal in the remaining cells continued.

In cell 1 more cleaning is required.

The levels in cells 2 and 3 are now comparable to the levels in cells 5 and 6 before the in-cell cleaning. The "hottest" spots could neither be seen by the in-cell camera, nor be removed by vacuum cleaning. They were removed by pushing some adhesive sponges exactly on the spots; the source appeared to be some tiny ^{60}Co particles. Cells number 2 and 3 are ready for the final treatment as for cells 5 and 6.

5. COLLECTIVE DOSES

A collective dose of approximately 16.3 man-mSv was ascribed to 18 persons in the first half of 1993, arising mainly from the in-cell work and from handling of waste.

6. REMAINING WORK

The remaining work consists in the following tasks:

- final cleaning of the remaining four cells;
- removal of all remaining cell ventilation equipment and filters;
- checking/cleaning of the room ventilation system;
- checking/cleaning of classified rooms;
- removal of active drains in the building.

7. CONCLUSION

The decommissioning work has progressed well during the first half of 1993.

The main results for the period were:

- removal of the last waste from the cells;
- remote cleaning of cells 2 and 3;
- final condition for all shutters and shutter housings;
- final condition for cells 5 and 6.

8. ACKNOWLEDGEMENT

All measurements and calculations on activity and contamination were performed by the Applied Health Physics Section in the Safety Department, RISØ.

Table 1: Calculated contamination on shutters and shutter housings.

Shutter between cell X/cell Y	Measured γ -act. [μSv/h]		Calc. ^{137}Cs contam. [MBq/m^2]		Calc. ^{137}Cs contam. [MBq]	Removed [pct.]
	before wiping	after wiping	before wiping	after wiping	after wiping	
1/2	62.3	25.8	39.4	16.3	228	59
2/3	78.5	49.5	49.7	31.3	438	37
3/4	48.0	21.0	30.4	13.3	186	56
4/5	50.0	15.0	31.6	9.5	133	70
5/6	-	8.0	-	5.1	71	-

Table 2: Measured contamination levels in cell 5.

Position	Radionuclide before and after cleaning, [Bq/m²]											
	^{60}Co		^{134}Cs		^{137}Cs		^{152}Eu		^{154}Eu		α-nuclides	
	before	after	before	after	before	after	before	after	before	after	before	after
Table, right	1.1 E5	1.0 E4	1.3 E5	2.9 E4	3.2 E6	1.0 E6	6.2 E3	1.4 E2	5.7 E4	2.6 E3	1.9 E5	5.9 E4
Table, left	2.4 E5	3.9 E3	2.4 E5	1.1 E4	4.3 E6	3.5 E5	1.4 E3	1.1 E3	7.4 E4	1.2 E3	2.2 E5	8.4 E4
Wall	6.3 E4	1.4 E3	4.6 E4	1.8 E3	1.8 E6	6.9 E4	8.0 E2	0.0 E0	3.5 E4	2.8 E2	2.1 E5	1.5 E4
Floor, right	2.1 E8	1.0 E4	3.2 E8	2.9 E4	1.5 E10	1.0 E6	5.7 E5	8.6 E2	2.6 E8	2.5 E3	1.2 E6	1.6 E5
Floor, left	3.8 E5	2.1 E5	8.2 E5	1.4 E4	2.1 E7	4.4 E5	5.5 E3	0.0 E0	3.9 E5	1.3 E3	2.5 E6	1.9 E5

Table 3: Measured contamination levels in cell 6.

Position	Radionuclide before and after cleaning, [Bq/m²]											
	^{60}Co		^{134}Cs		^{137}Cs		^{152}Eu		^{154}Eu		α-nuclides	
	before	after	before	after	before	after	before	after	before	after	before	after
Table, right	9.7 E5	4.8 E4	6.3 E5	1.4 E4	2.1 E7	3.5 E5	4.9 E3	2.9 E2	2.6 E5	6.5 E3	6.8 E4	1.6 E4
Table, left	9.1 E4	2.6 E4	1.0 E5	3.0 E4	2.6 E6	6.4 E5	3.3 E3	1.3 E3	4.1 E4	1.3 E4	-	-
Wall	8.4 E3	5.6 E3	1.1 E4	5.9 E3	2.0 E5	1.3 E5	5.5 E2	5.2 E2	3.2 E3	2.9 E3	1.8 E4	1.4 E4
Floor, right	1.5 E5	8.5 E4	1.1 E5	1.5 E5	2.6 E6	6.0 E6	2.5 E3	3.6 E3	3.8 E4	1.0 E5	4.1 E5	2.5 E5
Floor, left	8.4 E5.	2.3 E4	7.3 E5	3.0 E4	3.8 E7	1.3 E6	3.3 E4	8.3 E2	2.6 E5	2.1 E4	2.0 E5	2.7 E4

Table 4: Measured dose rates in cell 5.

Dosemeter	Position	Dose rate before cleaning [mSv/h]	Dose rate after cleaning [mSv/h]
A1	Table	1.20	1.80
A2		2.80	2.00
A3		7.00	6.50
B1		2.50	1.00
B2		2.10	1.80
B3		9.00	4.10
C1		1.60	1.15
C2		2.20	1.60
C3		8.00	3.60
D1		1.50	1.05
D2		2.50	2.00
D3		4.50	3.10
E1	Floor	1.80	1.60
E2		2.70	2.70
E3		6.00	6.10
F1		1.00	1.00
F2		1.30	1.90
F3		2.50	3.20
G1		2.20	1.30
G2		7.00	2.00
G3		8.00	4.60
H1		1.60	1.30
H2		3.00	2.30
H3		5.20	4.60

Dosemeters 1, 2 and 3 are at levels 195, 115 and 30 cm above the surface, respectively.

Table 5: Measured dose rates in cell 6.

Dosemeter	Position	Dose rate before cleaning [mSv/h]	Dose rate after cleaning [mSv/h]
A1	Table	0.35	0.30
A2		0.50	0.50
A3		3.00	0.70
C1		0.55	0.25
C2		0.70	0.50
C3		1.50	1.00
E1		0.45	0.25
E2		0.60	0.40
E3		1.20	4.40
H1		0.50	0.25
H2		0.90	0.40
H3		1.10	0.70
B1	Floor	0.90	0.45
B2		1.80	0.55
B3		3.00	0.60
D1		0.60	0.35
D2		1.20	0.70
D3		1.50	0.60
F1		0.70	0.25
F2		1.20	0.40
F3		4.00	1.40
G1		0.35	0.35
G2		0.70	0.90
G3		2.00	1.50

Dosemeters 1, 2 and 3 are at levels 195, 115 and 30 cm above the surface, respectively.

Table 6: Calculated total activity in cell 5, based on TL-dosemeter readings.

Dosemeter	Total activity before cleaning [GBq]	Total activity after cleaning [GBq]
A2	125	89
B2	109	93
C2	98	71
D2	129	103
E2	130	130
F2	70	103
G2	374	107
H2	154	118
Average	149	102

Table 7. Calculated total activity in cell 6, based on TL-dosemeter readings.

Dosemeter	Total activity before cleaning [GBq]	Total activity after cleaning [GBq]
A2	21	21
B2	77	24
C2	34	24
D2	57	34
E2	27	18
F2	62	21
G2	28	37
H2	36	16
Average	43	24

Table 8: Summary of contamination levels in the shutter housings and in cells 5 and 6.

	Density [MBq/m²/housing]	Total [MBq/housing]
Contam. level in shutter housings	5 - 31	71 - 438

	Cell 5		Cell 6	
	[GBq/m²]	[GBq]	[GBq/m²]	[GBq]
From smear tests, before cleaning	-	40.	-	0.2
From TL-dosemeters, before cleaning	2.1	149	0.6	43
From TL-dosemeters, after cleaning	1.5	102	0.3	24